Climate Prediction for Climate Services: How the IPCC Got Involved in Verifying the Climate Information

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Climate Forecasting Unit

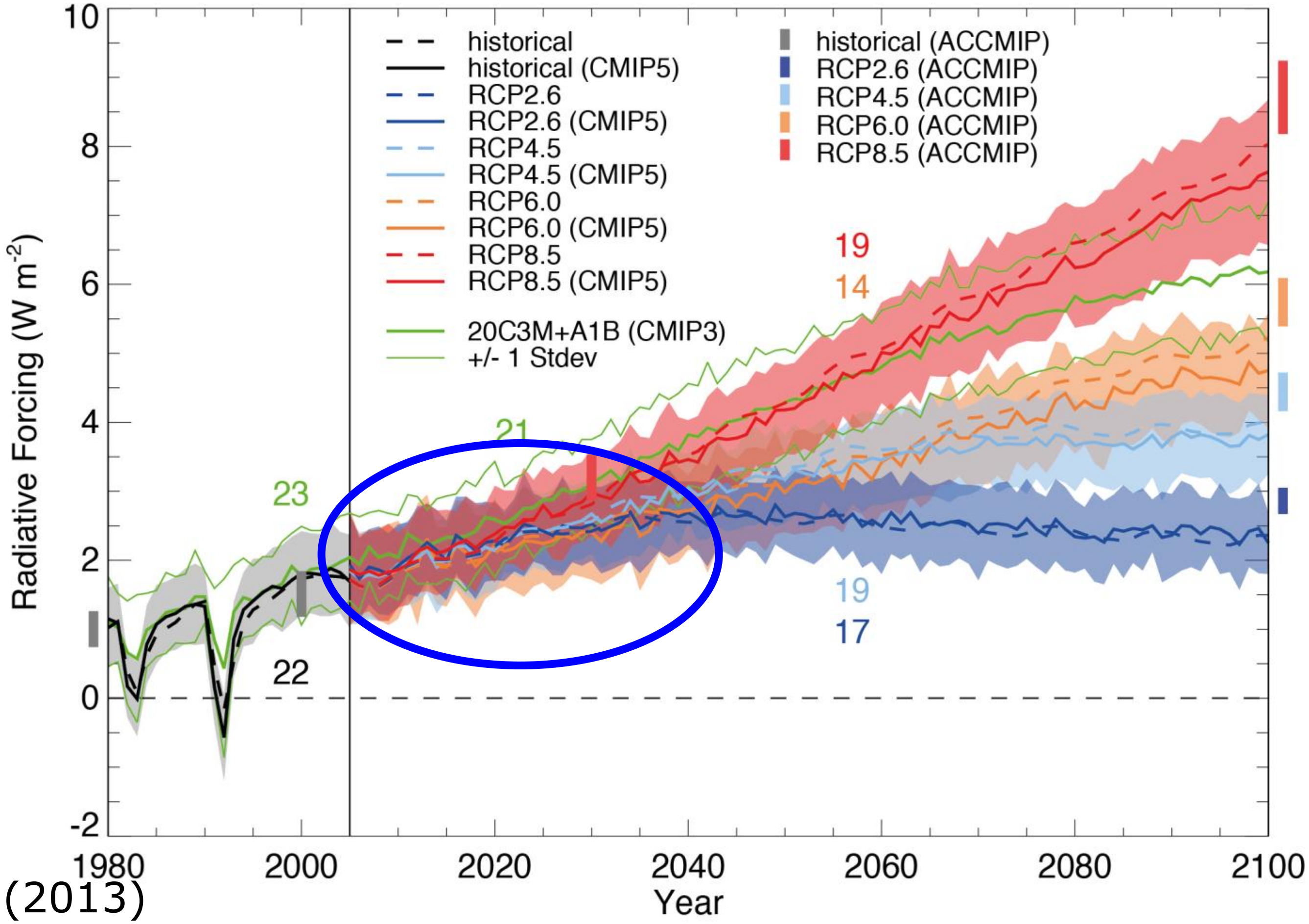
SEVENTH FRAMEWORK PROGRAMME

SPECS
Seasonal-to-decadal climate Prediction for the improvement of European Climate Services

Radiative forcing in climate change

Global mean radiative forcing (Wm^{-2}, dashed) and effective radiative forcing (solid) between 1980 and 2100 with 1850 as baseline.

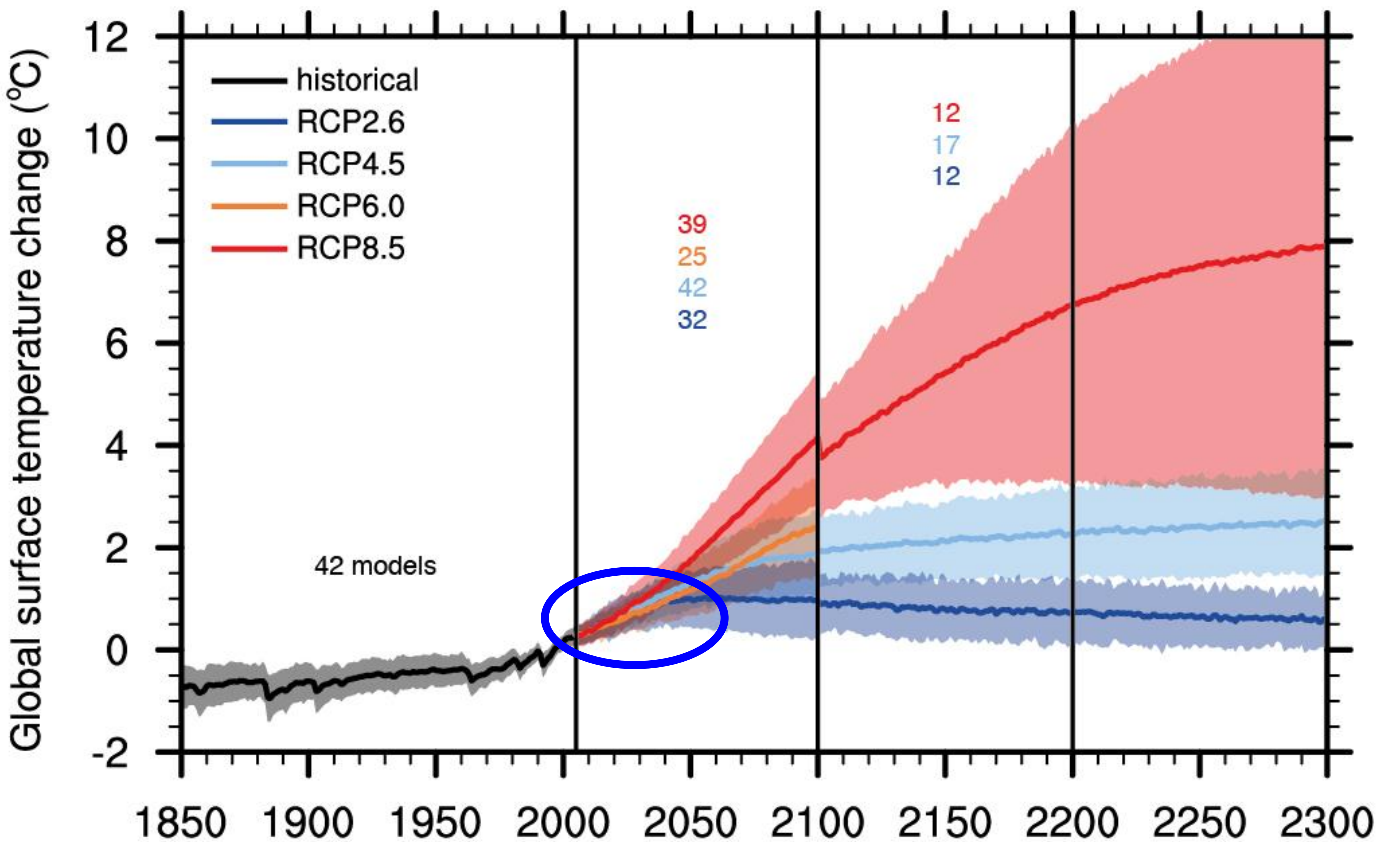
There is little difference between the RCPs until 2040.



IPCC AR5 WGI (2013)

CMIP5 projections

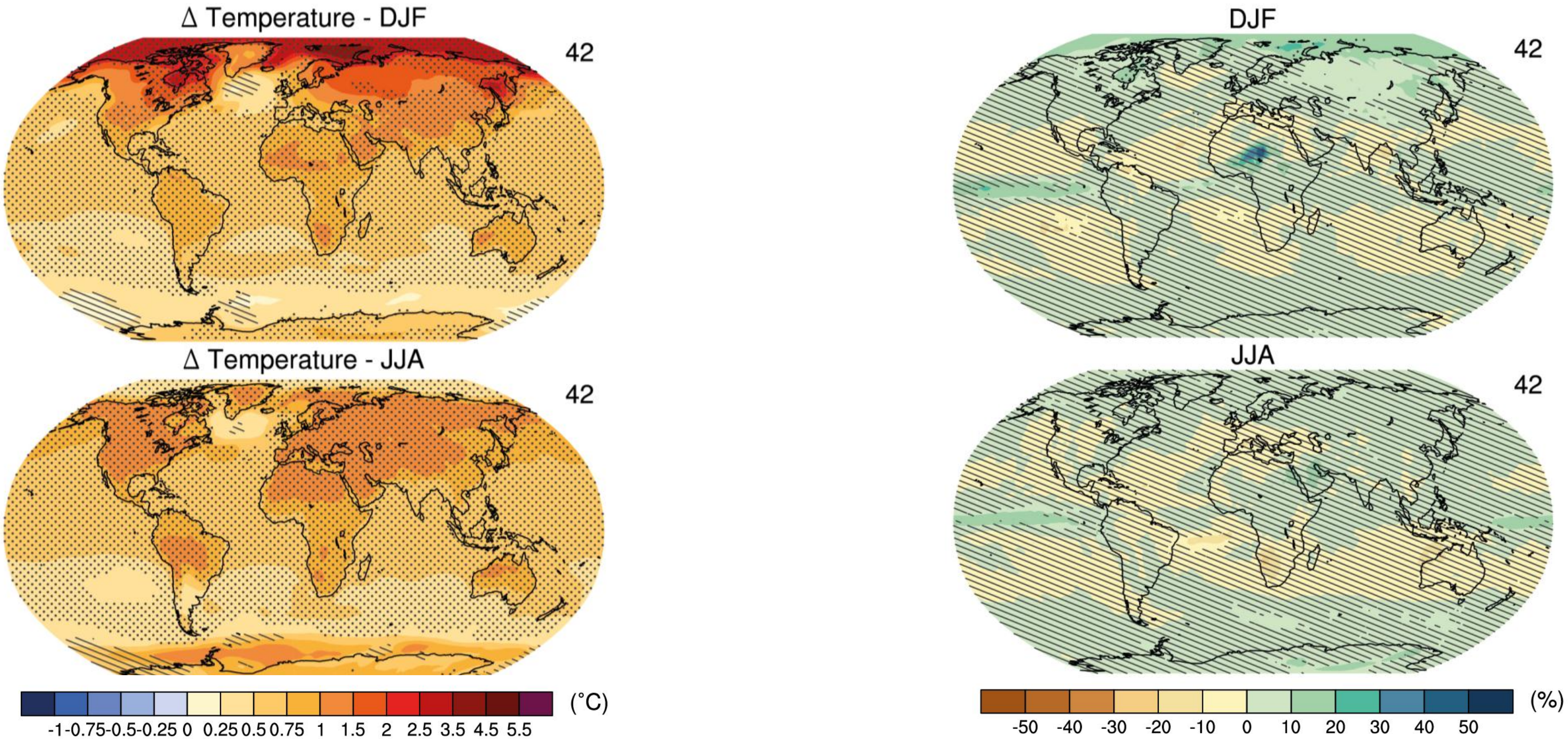
Time series of global annual mean surface air temperature anomalies (relative to 1986–2005) from CMIP5 concentration-driven experiments.



IPCC AR5 WGI (2013)

CMIP5 near-term projections

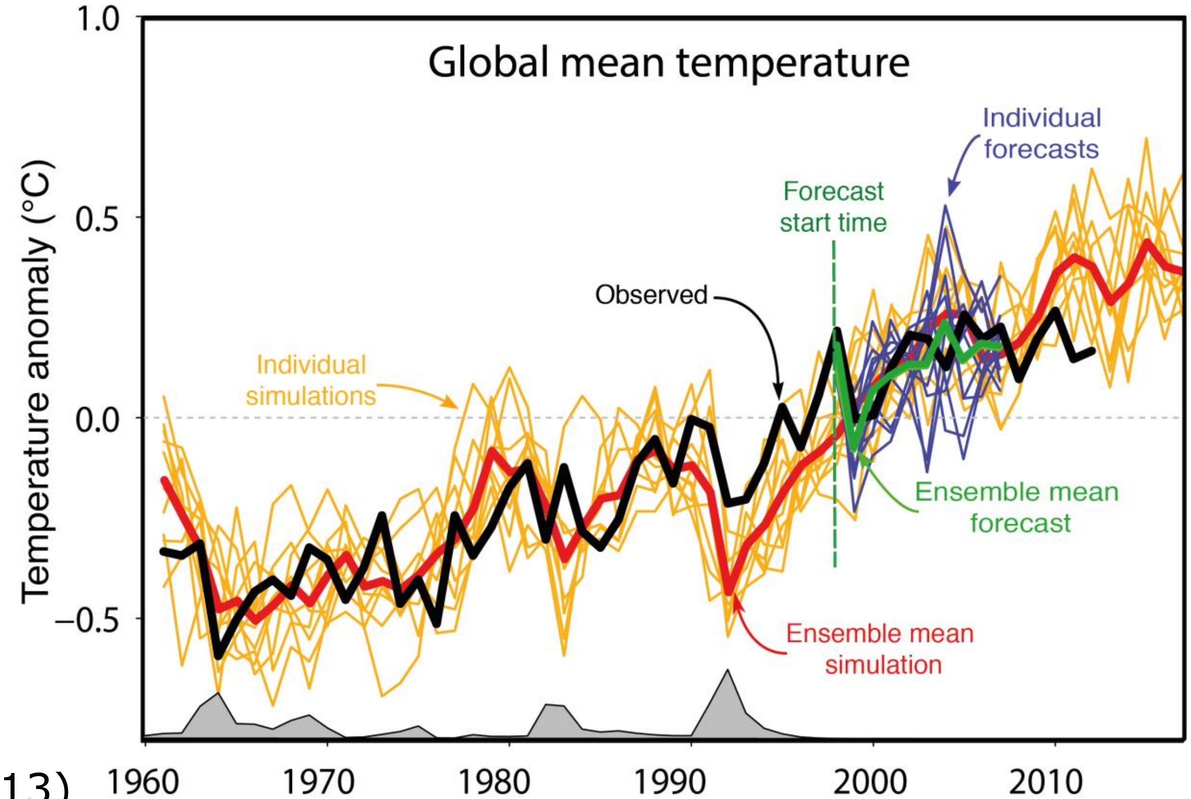
Seasonal-mean air temperature and percentage precipitation change for the RCP4.5 scenario over 2016-2035 (wrt 1986-2005). Stippling for significant changes, hatching for non-significant.



IPCC AR5 WGI (2013)

CMIP5 simulations

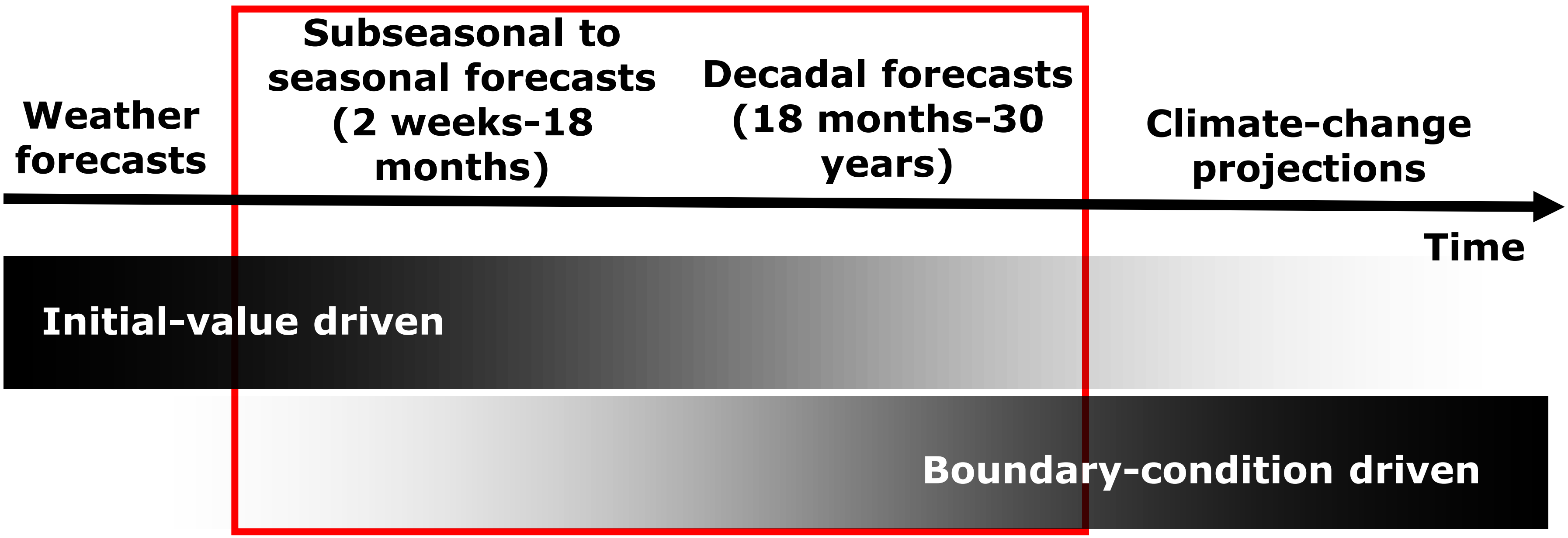
Time series of global-mean annual mean surface air temperature anomalies (relative to 1986–2005) from CMIP5 simulations (yellow lines). An ensemble of forecasts of global annual mean temperature initialized in 1998 is plotted as thin purple lines (average, green line). The grey areas along the axis indicate the presence of external forcing associated with volcanoes.



IPCC AR5 WGI (2013)

Climate prediction

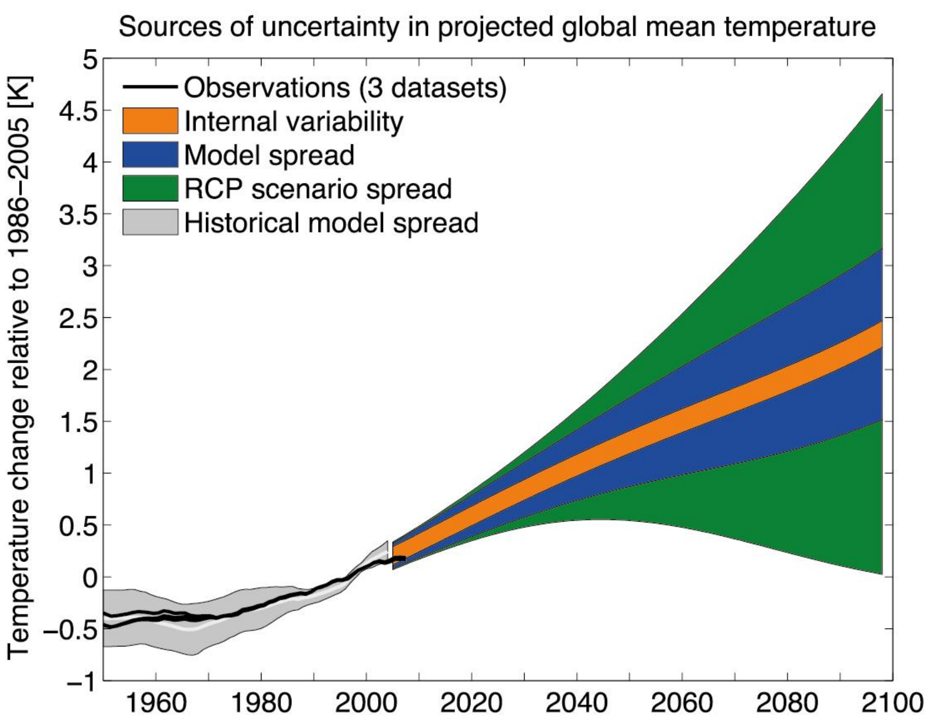
Progression from initial-value problems with weather forecasting at one end and multi-decadal to century projections as a forced boundary condition problem at the other, with climate prediction (sub-seasonal, seasonal and decadal) in the middle. Prediction involves initialisation and systematic comparison with a simultaneous reference.

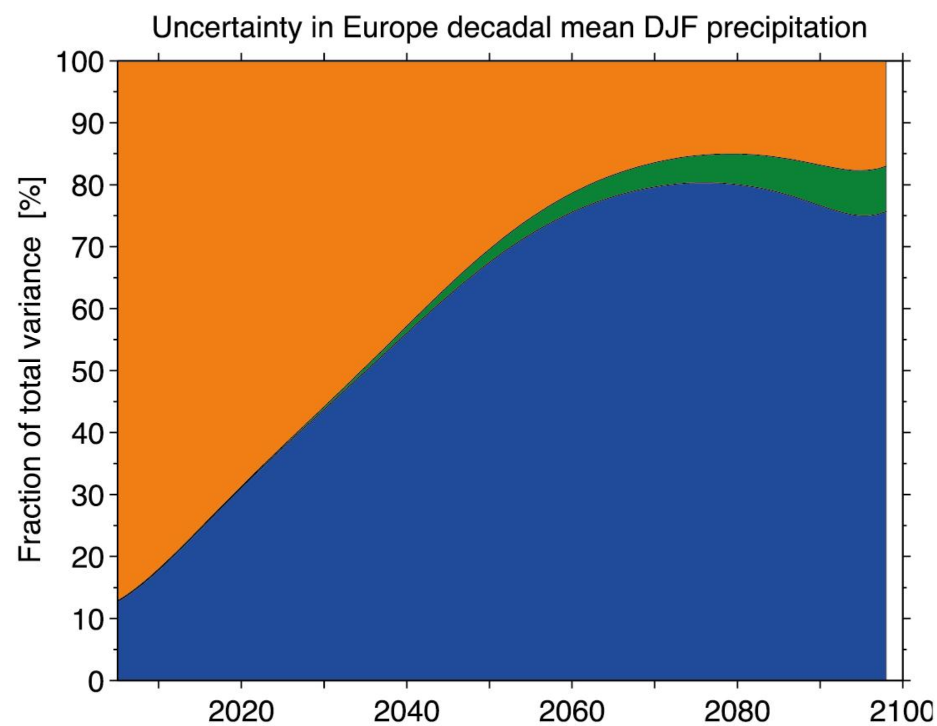


Adated from Meehl et al. (2009)

The hope to predict

The sources of uncertainty include the internal variability, model differences and scenario spread. The internal variability is an uncertainty source particularly important for the near term that could be reduced, especially at regional scales.

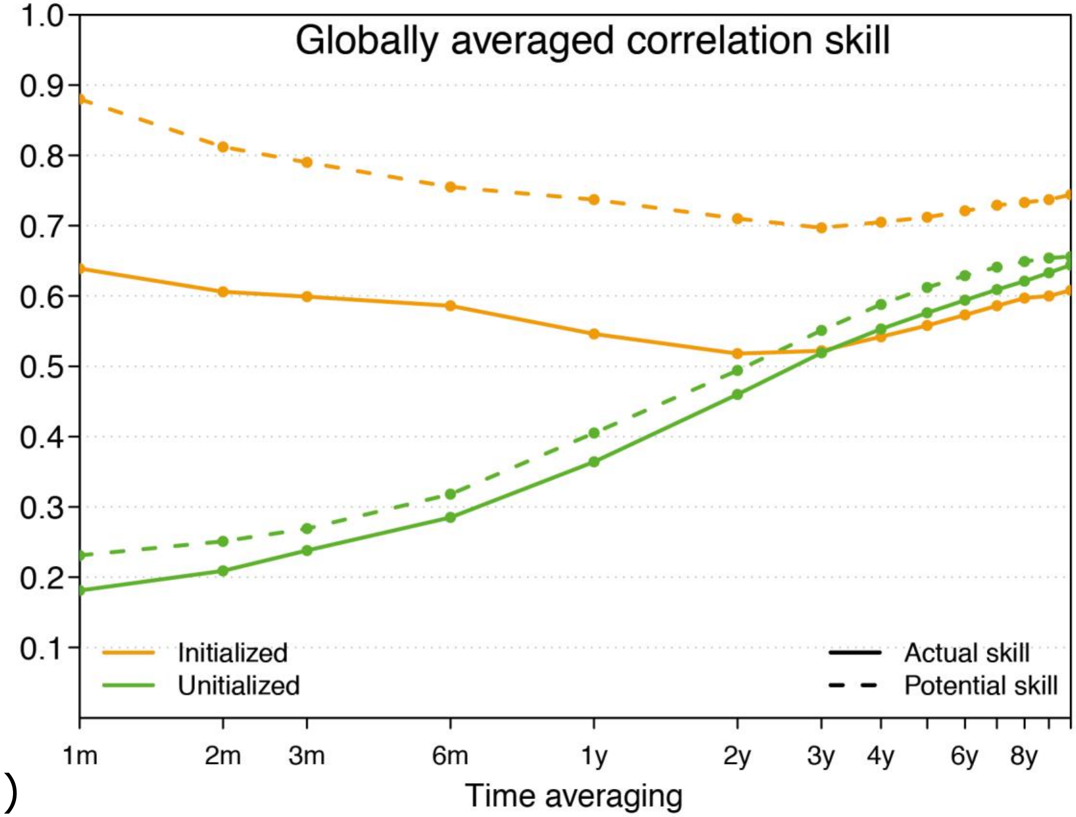




IPCC AR5 WGI (2013)

The hope to predict

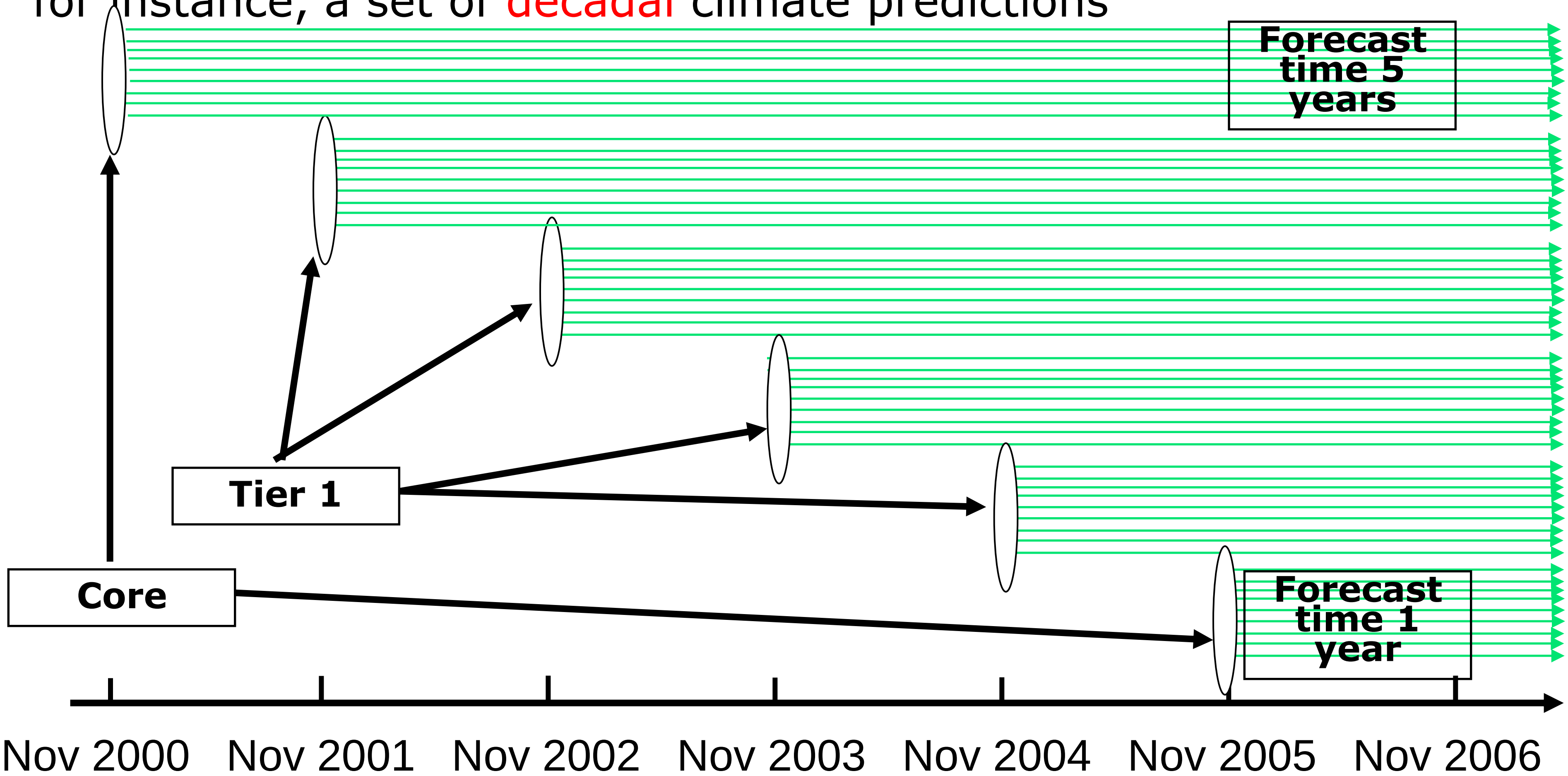
Global average of the grid-point correlation of the ensemble mean of temperature for initialised forecasts (solid orange lines) and the corresponding predictability measure (dashed orange). The equivalent estimates are shown in green for the uninitialised simulations. Results are for averages over periods from a month to a decade.



IPCC AR5 WGI (2013)

Climate predictions

Assume an ensemble forecast system with an initialized ESM to perform, for instance, a set of decadal climate predictions

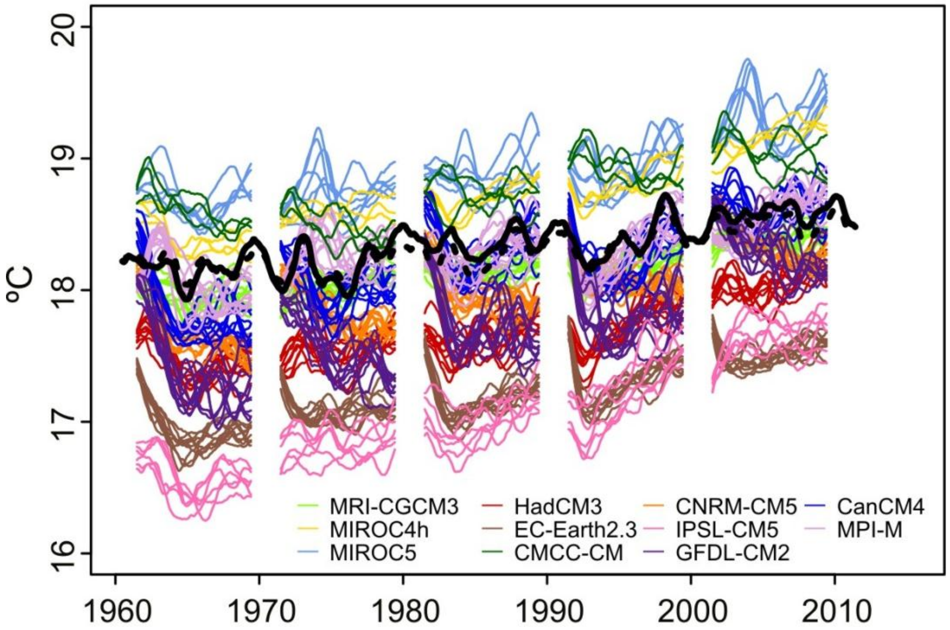


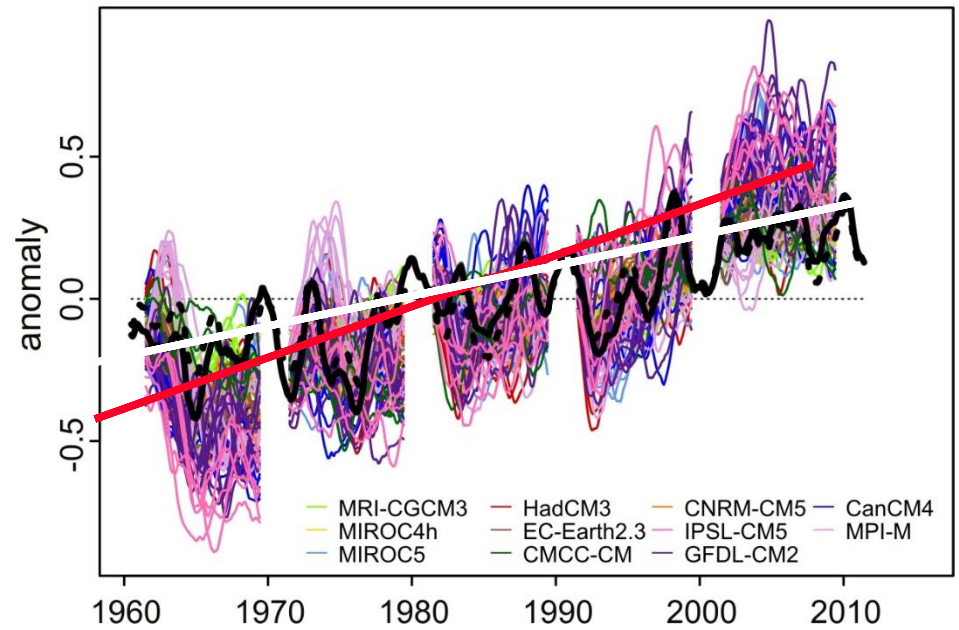
Predictions are also made with empirical forecast systems to be used as benchmarks and to detect untapped sources of predictability.

Shock, drift and systematic error

Global mean near-surface air temperature over the ocean (*one-year running mean applied*) from the CMIP5 hindcasts. Each system is shown with a different colour. NCEP and ERA40/Int used as reference.

The systematic error is very different from one system to another.



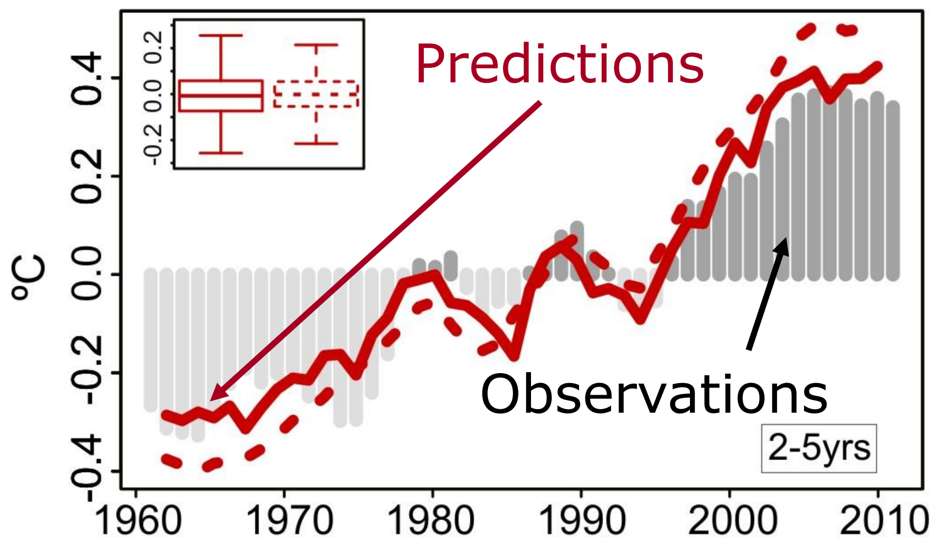


IPCC AR5 WGI (2013)

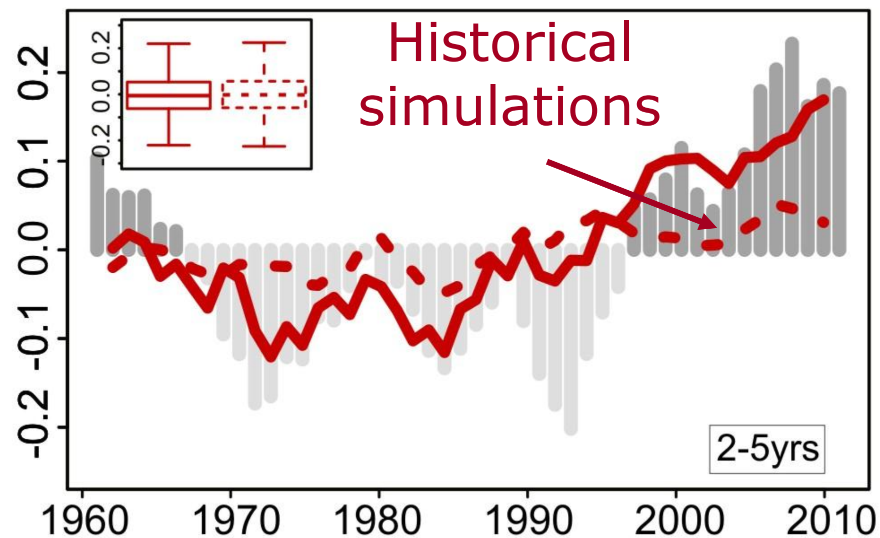
CMIP5 decadal predictions

CMIP5 decadal predictions. Global-mean t2m and AMV against GHCN/ERSST3b for forecast years 2-5. **The initialised experiments reproduce the GMST trends and the AMV variability and suggest that initialisation corrects the forced model trend and phases in some of the internal variability.**

Global mean surface atmospheric temperature



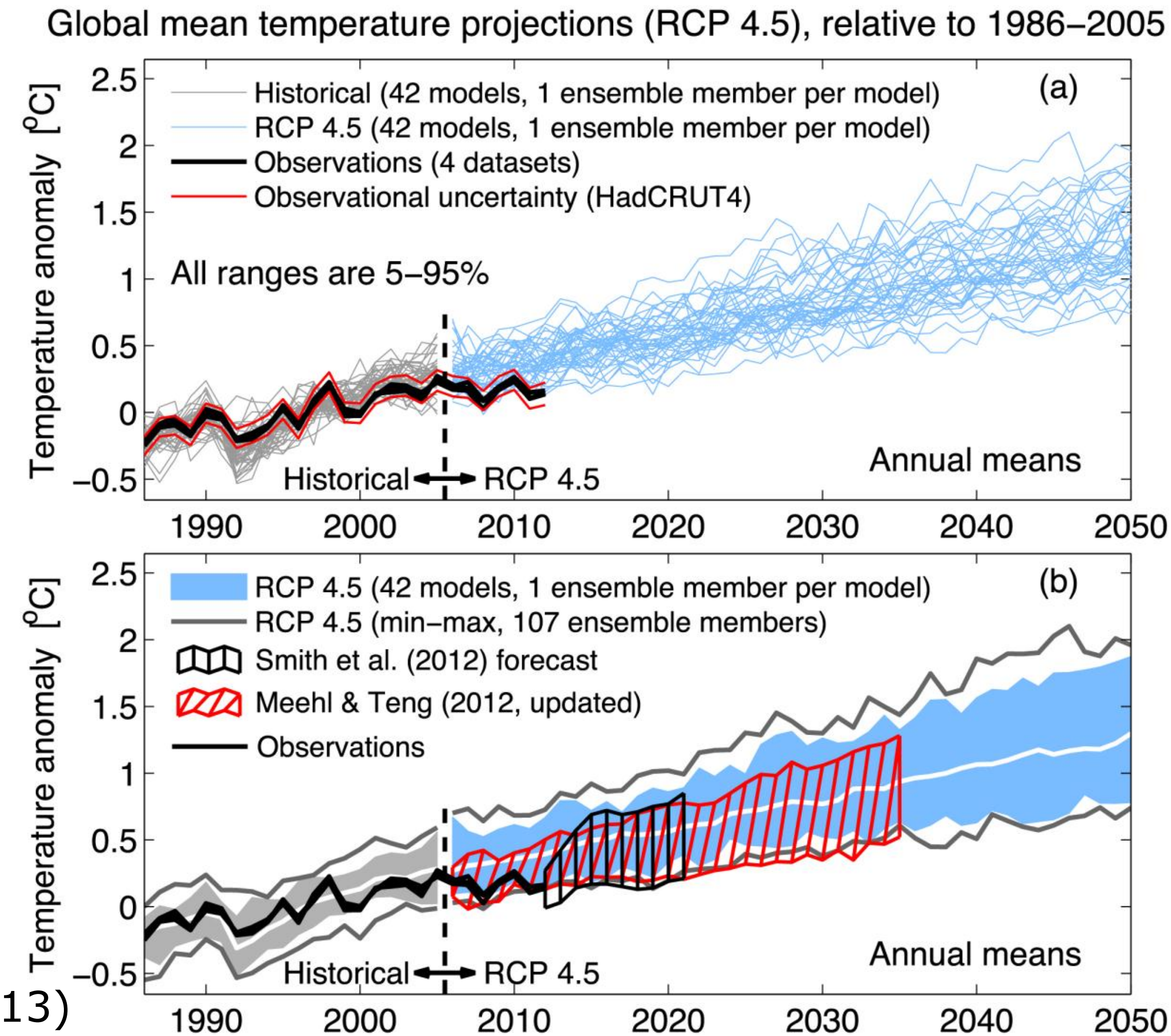
Atlantic multidecadal variability (AMV)



Doblas-Reyes et al. (2013)

CMIP5 predictions and projections

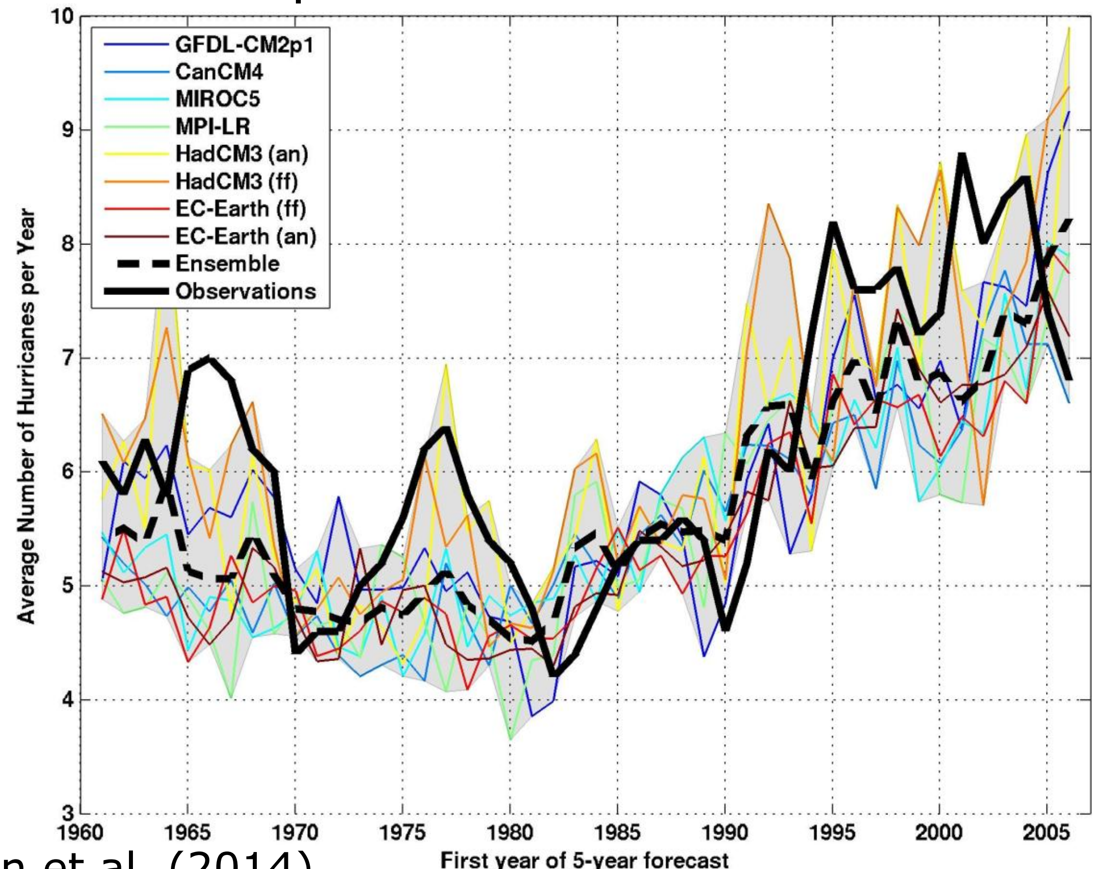
Annual-mean global-mean temperature predictions and projections from CMIP5.

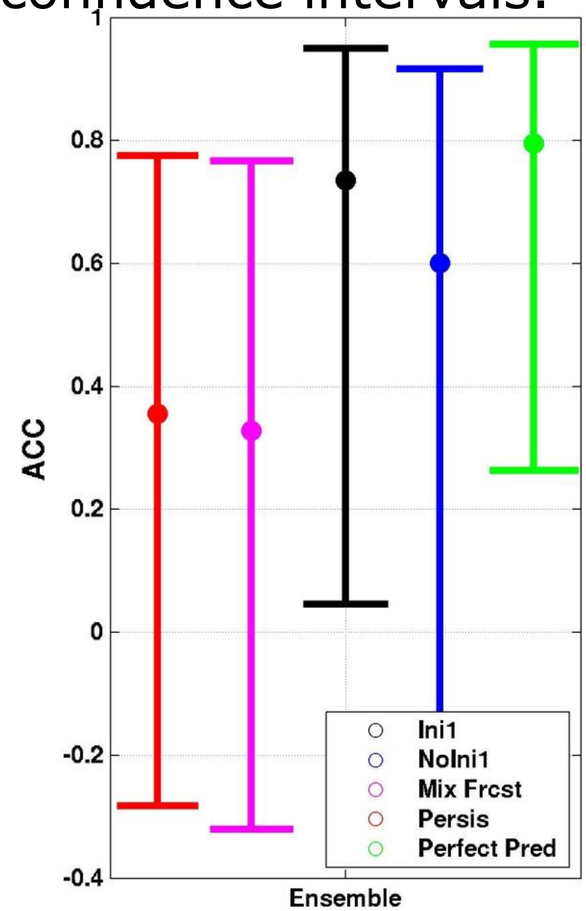


IPCC AR5 WGI (2013)

Hurricane frequency prediction

Average number of hurricanes per year estimated from observations and from the CMIP5 multi-model decadal prediction ensemble (forecast years 1-5). The correlation of the ensemble mean for the initialized, uninitialized and statistical predictions are shown with the 95% confidence intervals.

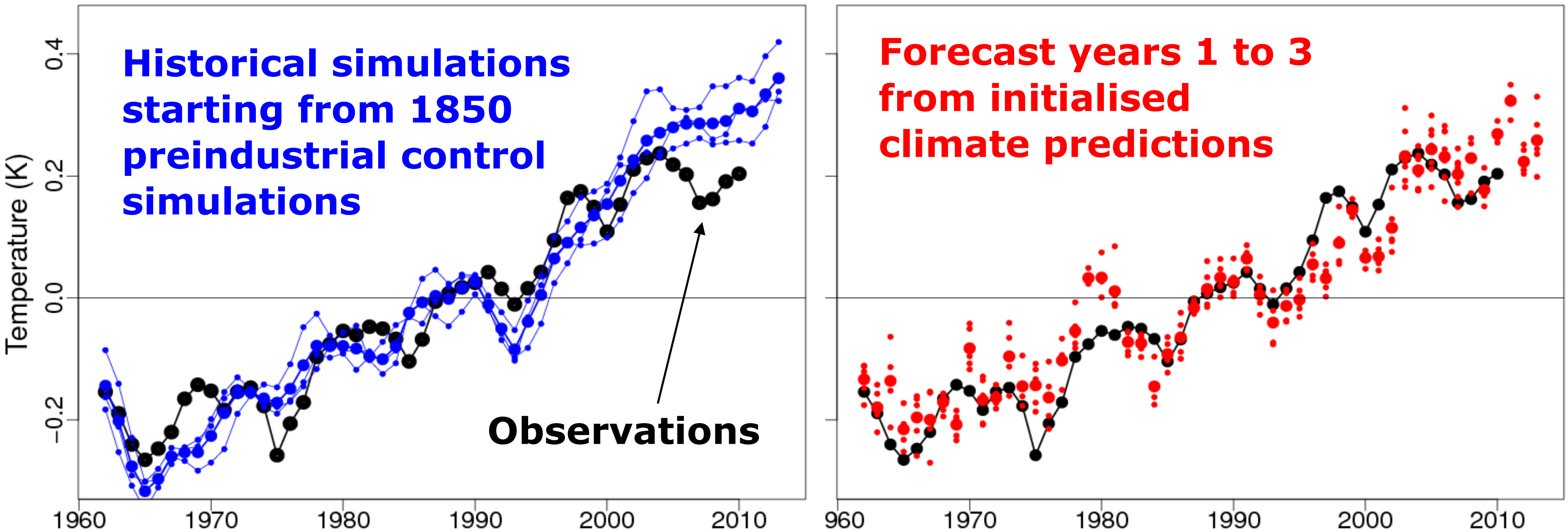




Caron et al. (2014)

Attribution of the XXIst century hiatus

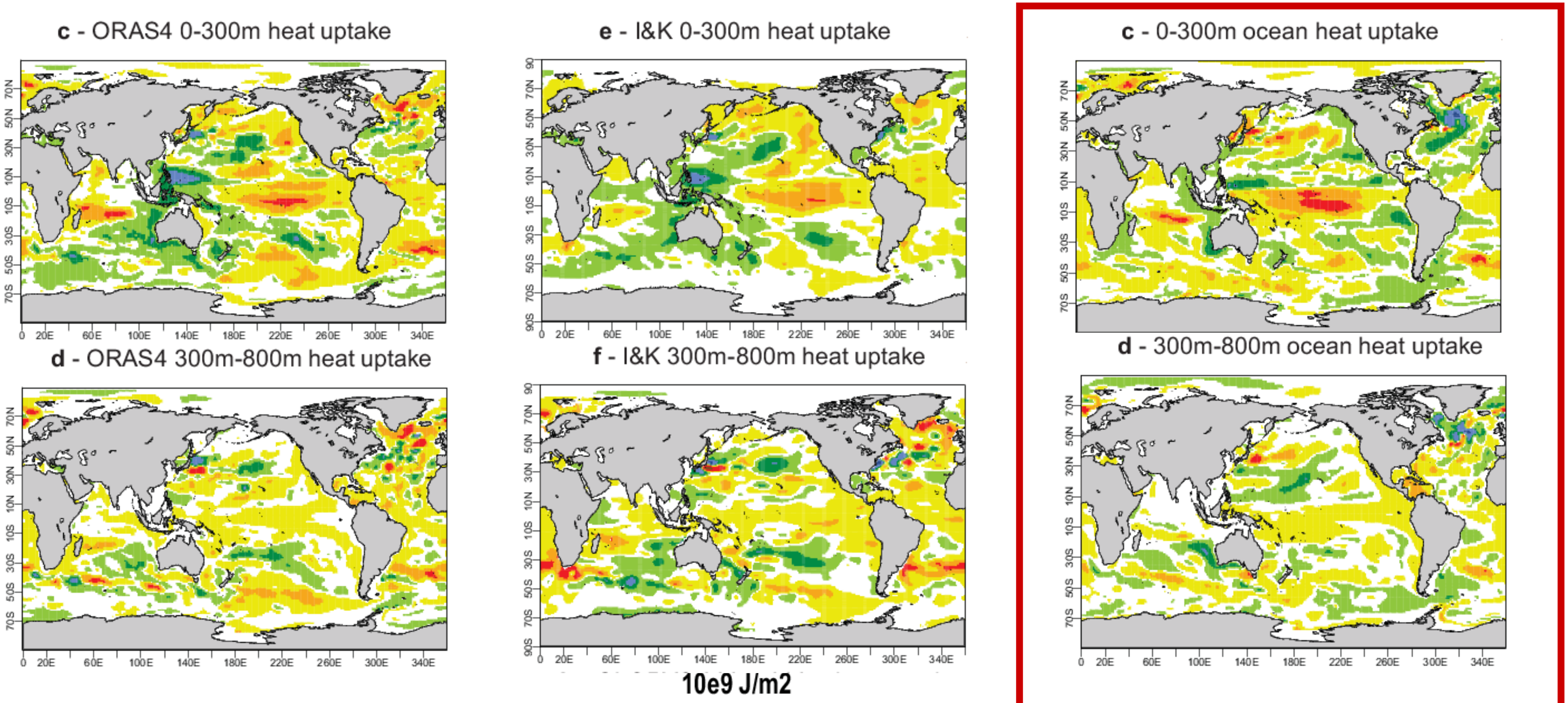
Predictions of the recent global-temperature slow down with EC-Earth 2.3. Global-mean SST from observations (ERSST) and simulations, three-year averages. The experiments suggest an important role of the internal variability, especially the oceans, in the hiatus.

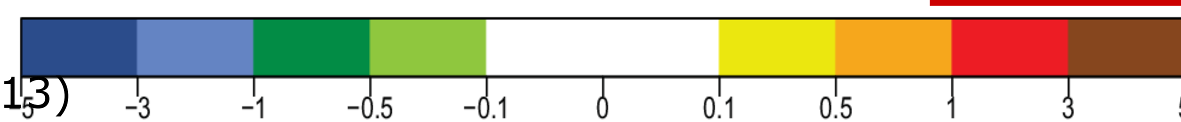


Guemas et al. (2013)

Hiatus in the ocean

Ocean heat uptake as the average of differences over (2001,2003)-(1998-2000), (2002,2004)-(1999,2001) and (2003,2005)-(2000,2002) for two ocean layers, two reanalyses and the EC-Earth2.3 2-4 year predictions.





Guemas et al. (2013)

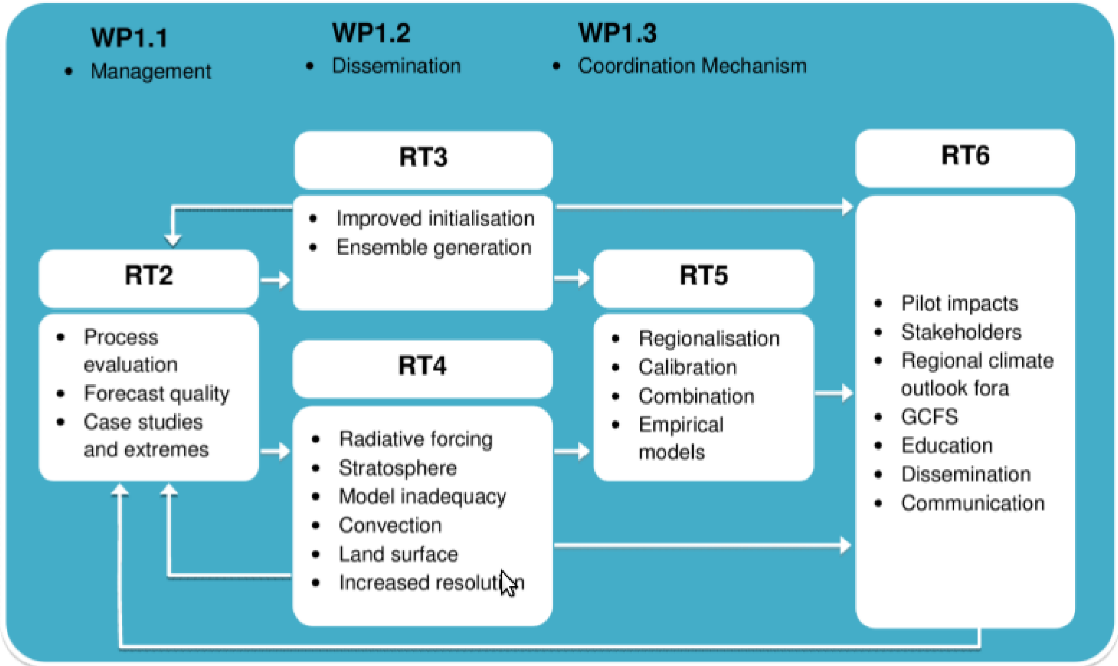
Some open fronts

- Work on initialisation: initial conditions for all components (including better ocean), better ensemble generation, etc. Link to observational and reanalysis efforts.
- Model improvement: leverage knowledge and resources from modelling at other time scales, drift reduction. More efficient codes and adequate computing resources.
- Calibration and combination: empirical prediction (better use of current benchmarks), local knowledge.
- Forecast quality assessment: scores closer to the user, reliability as a main target, process-based verification.
- Improving physical processes: sea ice, projections of volcanic and anthropogenic aerosols, vegetation/land, …
- More sensitivity to the users' needs: going beyond downscaling, better documentation (e.g. use the IPCC language), demonstration of value and outreach.

SPECS FP7, overall strategy

SPECS will deliver *a new generation of European climate forecast systems, including initialised Earth System Models (ESMs) and efficient regionalisation tools to produce quasi-operational and actionable local climate information over land at seasonal-to-decadal time scales with improved forecast quality and a focus on extreme climate events, and provide an enhanced communication protocol and services to satisfy the climate information needs of a wide range of public and private stakeholders*.

Forecast System	Project Partners
CNRM-CM5	CNRM, CERFACS
EC-Earth	KNMI, SMHI, IC3, ENEA
IFS/NEMO	ECMWF, UOXF
IPSL-CM5	CNRS
MPI-ESM	MPG, UniHH
UM	UKMET



WP1.1: Management
WP1.2: Dissemination
WP1.3: Coordination across EUPORIAS, NACLIM & SPECS
RT2: Evaluation of current s2d forecast systems
RT3: Forecast strategies
RT4: Improved systems
RT5: Calibrated predictions at the local scale

SPECS Seasonal-to-decadal climate Prediction for the improvement of European Climate Services

Real-time decadal prediction

Multi-model real-time decadal prediction exchange will request additional support at CCl16. Very simple: research exercise, we can learn a lot from this; prevent over-confidence from a single model; equal ownership.
http://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/long-range/decadal-multimodel

Multi-model decadal forecast exchange

The Met Office coordinates an informal exchange of near-real time decadal predictions. Many institutions around the world are developing decadal prediction capability and this informal exchange is intended to facilitate research and collaboration on the topic.

The contributing prediction systems are a mixture of dynamical and statistical methods. The prediction from each institute is shown below, alongside an average of all the models. When possible, observations for the period of the forecast are also shown. Currently three variables are included: surface air temperature, sea-level pressure and precipitation. These are shown as differences from the 1971-2000 baseline. More diagnostics, including ocean variables are planned for the future. Please use the drop-down menus below to explore the data collected to date.

This work is supported by the European Commission SPECS project.

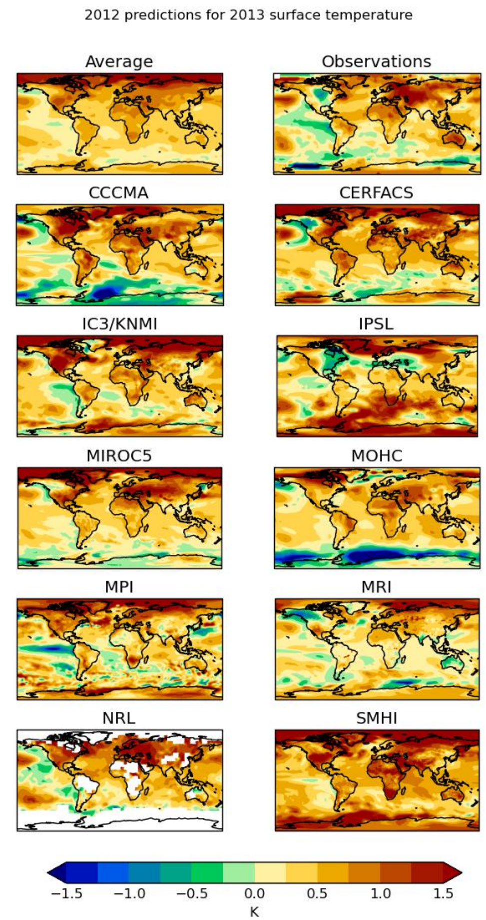
SPECS
Seasonal-to-decadal climate Prediction for the improvement of European Climate Services

To learn more about decadal forecasts at the Met Office, see our current decadal forecast.

Images last updated 2014-06-25

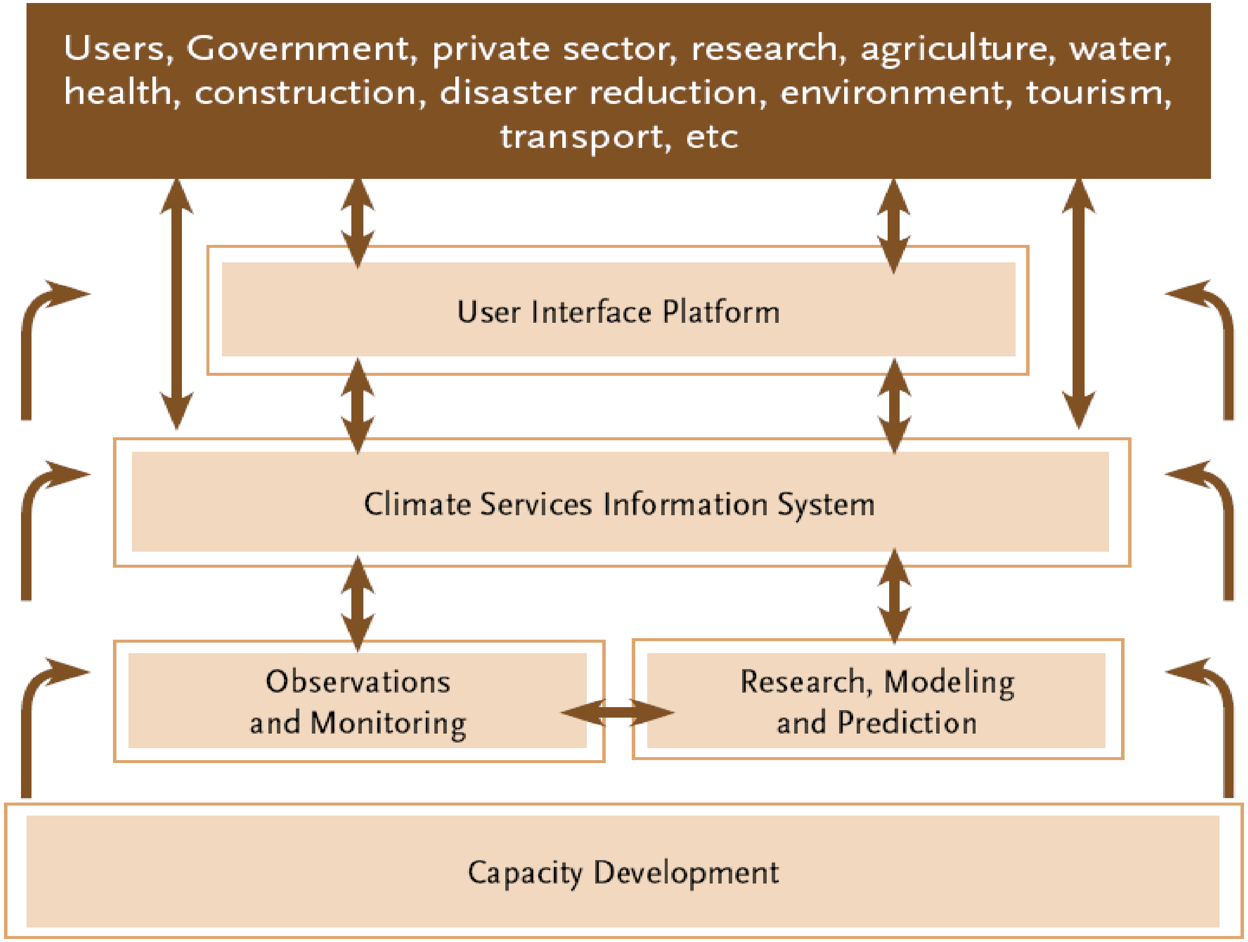
Issued	Period	Element
2013	year 1	surface air temperature

Decadal forecast exchange 2013 predictions for year 1 surface air temperature



How to proceed with all this?

Global Framework for Climate Services (GFCS): using climate predictions as a new adaptation tool. Climate Services focus on the transformation of climate-related data into customized products.



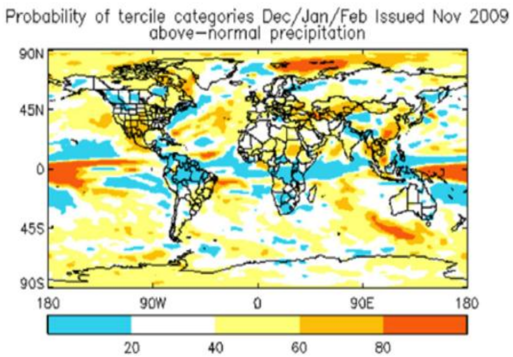
Climate services

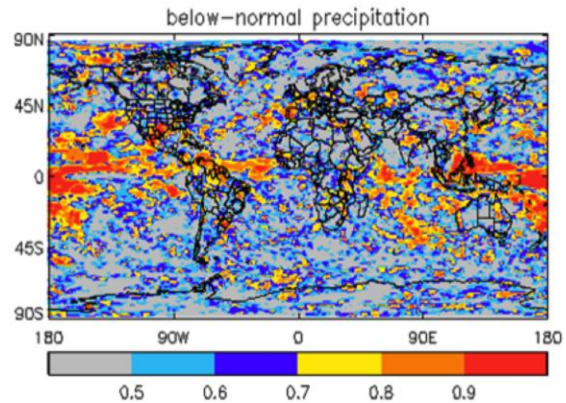
The five requirements for climate services to be relevant:

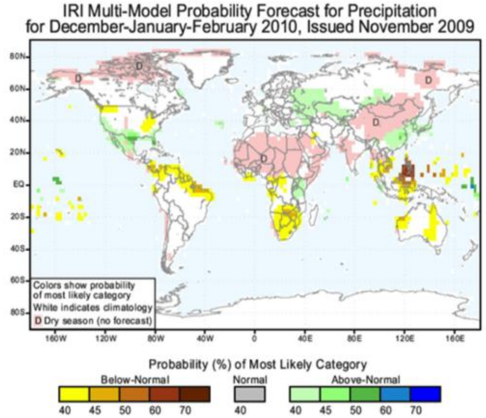
- A true climate services function to enable effective responses: services function if there is a significant link between climate and human/eco systems.
- The ability to anticipate makes knowledge powerful. Bring the forecasting discipline to a wider family of products.
- The coupling of the physical sciences, human dimensions and impact sciences is rarely co-located in institutions or funding agencies.
- There is a need to tackle the issue of scale and the demand for an integrated approach.
- Evolve from independent climate services and modelling efforts to “environmental intelligence” centres ensuring vigorous connection with users and decision makers.

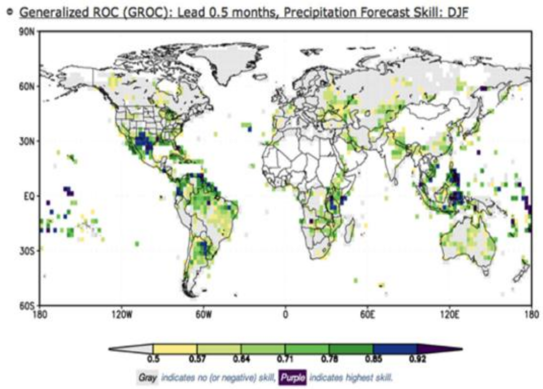
Communication challenges

DJF 2009/10 probabilistic forecasts for precipitation from Met Office and IRI and their verification.









Some of the things badly missing

- Better understanding of the impact models, and the best way to adapt them to the useful climate information available
- Bias correction, calibration and combination
- Downscaling, when necessary
- Documentation (some stakeholders are used to the IPCC calibrated language, which is different to the climate forecasting language), demonstration of value and outreach
- The EUPORIAS FP7 project, working alongside the SPECS project, is considering solutions to address some of these problems.

EUPORIAS: prototypes

- EUPORIAS intends to maximise the societal benefit of climate prediction technologies and, hence, increase the resilience of European society to climate change by demonstrating how climate information becomes usable.
- A set of prototypes, examples of a climate service for s2d time scales in Europe, are the main project outcome.
- Six proposals selected by an external panel based on value to the users, skill in the predictions, stakeholder engagement, robustness of the impact model:
  - Outlook for UK winter conditions to inform transport industry
  - Food security in East Africa for WFP
  - Winter land management for Clinton Devon Estate
  - Renewable energy management (RESILIENCE)
  - River management in two French catchment areas
  - Hydroelectric production in Sweden

The wind energy problem

To satisfy the users' requirements for sub-seasonal to seasonal forecast information:

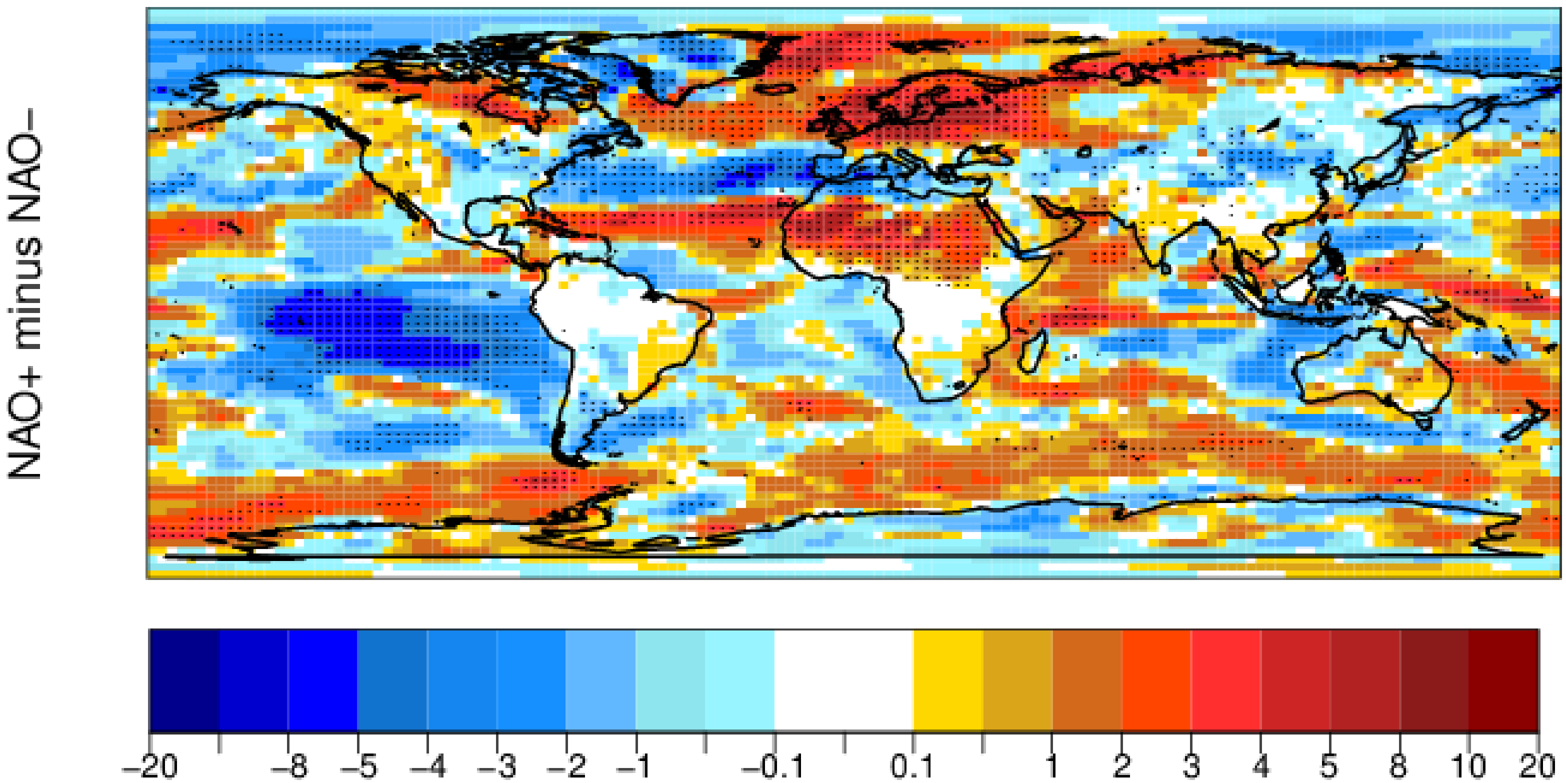
- High-frequency wind forecasts at ~100 metre height
- Bias corrected forecast data, i.e. whose statistical properties mimic those of the data measured at the wind turbine height -> Bias correcting and calibrating high-frequency data is extremely complicated and destroys the little skill available

On top of this:

- Local measurements are not long
- They are not even made available

The wind energy problem

Difference in winter (DJF) standardised capacity factor for seasons with positive and negative North Atlantic Oscillation index.



But this is just a small effort

Example of a national energy modelling system.

We only address this part.